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# **COATING and CHEMICAL LABORATORY**

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64-4

CCL REPORT NO. 147

DESERT FIELD TEST - ALL WEATHER BRAKE FLUID

BY

CHARLES B. JORDAN

AMCAMS CODE NO. 5025.11.802  
DA PROJECT I-H-0-24401-108

16 AUGUST 1963

418590

**ABERDEEN PROVING GROUND  
MARYLAND**

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Report No. CCL # 147

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DESERT FIELD TEST - ALL WEATHER BRAKE FLUID

By

Charles B. Jordan

16 August 1963

AMCMS Code No. 5025.11.802

Dept of the Army Project No.  
I-H-0-24401-108

U. S. Army Coating and Chemical Laboratory  
Aberdeen Proving Ground  
Maryland

UNCLASSIFIED

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C. F. PICKETT, Technical Director  
U.S. Army Coating and Chemical Laboratory

ABSTRACT

The object of this test was to evaluate the high temperature field performance of an all-weather hydraulic brake fluid. This report covers the results of desert tests at Yuma Test Station, Arizona.

New brake cylinders were packaged with the all-weather brake fluid and installed on  $\frac{1}{4}$  ton,  $\frac{3}{4}$  ton,  $2\frac{1}{2}$  ton and 5 ton facility vehicles; all-weather fluid was placed in the brake systems; the vehicles were then placed in normal facility operation during the test period of 12 June 1962 to 25 February 1963.

The all-weather brake fluid performed satisfactorily in all vehicles throughout the test period.

## I. INTRODUCTION

Aberdeen Proving Ground, Maryland, was requested by Research and Engineering Directorate, OTAC, ORDMC-RP.4, AUS-20 dated 29 November 1961, to conduct field tests on an all-weather brake fluid. This fluid had been developed by the Coating and Chemical Laboratory (CCL Report No. 115) and combined the essential high temperature requirements of Federal Specification VV-H-910a, Hydraulic Fluid, Non-Petroleum Base, Automotive and the low temperature requirements of Military Specification MIL-H-13910, Hydraulic Fluid, Non-Petroleum Base, Automotive Brake, Arctic.

Two phases of testing were outlined: (a) High temperature testing at Yuma Test Station, Arizona; (b) Arctic testing at Fort Wainwright, Alaska. This report covers results of the high temperature field tests at Yuma Test Station.

## II. DETAILS OF TEST

### A. Test Vehicles

Ten vehicles listed in Table I, Appendix B, were used in this test. These vehicles were facility vehicles in use at Yuma Test Station and consisted of 3 -  $\frac{1}{4}$  ton, 2 - 3/4 ton, 2 - 2 $\frac{1}{2}$  ton, and 3 - 5 ton vehicles.

### B. Preparation of Vehicles for Test

All vehicles were prepared for test in accordance with Test Plan, Appendix A. One vehicle of each weight class was instrumented with thermocouples to measure brake fluid temperatures and air temperature in the vicinity of the cylinders. Thermocouples were installed at the master cylinder and on one wheel-cylinder per axle.

### C. Inspection of Vehicles During Test Period

Fluid level was checked periodically. A history of fluid additions, miles of operation, operating conditions, brake malfunctions and climatic conditions was recorded. This test was in operation from 12 June 1962 until 25 February 1963. At the completion of the test all brake cylinders were removed from the vehicles and forwarded to the laboratory for examination and evaluation.

## III. RESULTS OF TEST

### A. Inspection of Cylinders

Results of cylinder inspection are included in Table I, Appendix B. Test data supplied by field testing personnel included in Appendix C.

### B. Fluid Additions

Fluid additions at the completion of the test were greater than anticipated. In many instances the presence of sand inside the cylinders caused leakage. Other causes of leakage not attributable to brake fluid

deficiency, included three faulty air-hydraulic cylinders, faulty threads on one cylinder assembly, one damaged washer seal, one loose line fitting at a master cylinder, and the presence of foreign materials inside four cylinders.

#### C. Gum Deposits and Corrosion

Cylinders returned to the laboratory from five of the vehicles had not been forwarded to the testing activity for this field test. These cylinders contained moderate to heavy amounts of gummy residue. Cylinders which had been forwarded for the test contained slight to moderate amounts of gummy residue. All cylinders were operational. No excessive corrosion was noted. Rubber cups showed slight scuffing, especially in cylinders containing sand.

#### D. Examination of Fluid

Results of tests run on fluid removed from cylinders are listed in Table II, Appendix B. The decrease in boiling point is normal and attributed to condensed moisture. All samples of fluid contained some sediment; this sediment was analyzed and found to be high in silicon content. This indicated that sand and dust had accumulated in the cylinders. Some organic material was also found.

#### E. Temperature Data

Temperature data are listed in Appendix C. No extreme temperature readings were encountered. Ambient temperature recorded on test runs ranged from 76°F. to 113°F. Air temperature in the vicinity of the cylinders reached 151°F. The highest fluid temperature recorded during the test was 145°F. This is well below the boiling point of the brake fluid.

#### F. Malfunctions Caused by Brake Fluid Failure

No serious brake malfunctions attributable to the test fluid occurred during the test period.

### IV. DISCUSSION

The all-weather brake fluid performed satisfactorily in this field test. Leakage was not directly attributable to the fluid, but to mechanical failures and the presence of foreign material in the brake system.

The gum deposits in the cylinders did not hinder brake operation during the test period. These deposits, however, could lead to future difficulties. A dimer acid inhibitor was included in the brake fluid formulation used in this test. It is believed that this dimer could have caused part of the gum deposits which were found. Tests are being conducted on a modification of the brake fluid formulation in which the dimer has been eliminated.

Several of the cylinders used in this test had not been packaged for the test. Available history on the cylinders indicated that they had been packaged with brake fluid almost a year before installation in the test vehicles. Brake fluids generally are not good packaging fluids; this would account for some of the gum deposits found in these cylinders at the end of the test.

The fact that the major portion of the test was conducted during the winter months and lack of temperature data during the final few months of the test minimized the value of the test. However, since no operational malfunctions occurred, it was concluded that the brake fluid would be satisfactory in desert operation.

#### V. RECOMMENDATION

Based on this field test and Arctic field tests which have been completed it is recommended that the all-weather fluid be adopted for military usage.

It is further recommended that formulations which do not include the dimer acid be laboratory and field evaluated.

#### VI. REFERENCES

1. Authority: Research and Engineering Directorate, OTAC, ORDMC-RP.4, AOS-20 dated 29 November 1961.
2. Federal Specification VV-H-910a Hydraulic Fluid, Non-Petroleum Base, Automotive.
3. Military Specification MIL-H-13910, Hydraulic Fluid, Non-Petroleum Base, Automotive Brake, Arctic.
4. CCL Report No. 115, Development of An All-Weather Hydraulic Brake Fluid, dated 9 February 1962.

## **APPENDICES**

**Appendix A - Test Plan**

**Appendix B - Tables**

**Appendix C - Field Reports**

**APPENDIX A**

**Test Plan**

## TEST PLAN

### DESERT TESTING

1. Vehicles employed shall consist of the following facility vehicles at Yuma Test Activity, Yuma Test Station:

3 ea  $\frac{1}{2}$ -ton M38A1  
2 ea 3/4-ton M37  
1 ea  $2\frac{1}{2}$ -ton M108  
1 ea  $2\frac{1}{2}$ -ton M220  
2 ea 5-ton M62  
1 ea 5-ton M52

2. Brake fluid shall be removed from the system of each vehicle. Filtered compressed air shall be used to remove all existing fluid from lines. All brake cylinders (master and wheel) shall be removed and new cylinders installed. (New cylinders will be supplied by the Coating & Chemical Laboratory).
3. The brake system will be filled with the all-weather fluid, which will be supplied by the Coating & Chemical Laboratory. Brakes shall be adjusted for proper brake action.
4. A counter shall be installed for measuring brake applications.
5. Thermocouples shall be installed in positions to get brake fluid temperatures and air flow characteristics around the drums and brake wheel cylinders.
6. Vehicle shall be tagged stating that a brake test is in progress.
7. During the regular maintenance check-ups the fluid level in the master cylinder will be checked. Only test fluid will be added, and amounts recorded.
8. Memorandum reports shall be submitted to the Coating & Chemical Laboratory after 3 and 6 months. These reports shall include temperature data, miles of operation, number of brake applications, maintenance data, general road and terrain conditions and pertinent brake data.
9. After 6 months of service all brake fluid and brake cylinders shall be removed from the vehicles and forwarded to the Coating & Chemical Laboratory for inspection; evaluation, and analysis.

**APPENDIX B**

**Tables**

TABLE I

## DESERT FIELD TESTS CYLINDER INSPECTION

	1	2	3
Vehicle	1/4 ton	1/4 ton	1/4 ton
Class	M38A1	M38A1	M38A1
Reg. No.	20977124	20975780	2A9096
<u>Condition of Cylinders</u>			
<u>Master Cylinder</u>	Operational	Operational	Operational
Cylinder Walls	OK	Slight deposits	Excessive sandy deposits
Piston	Slight deposits	OK	Excessive sandy deposits
Cups	OK	Slight scuffing	Slight scuffing
<u>Wheel Cylinders</u>			
Cylinder Walls	Slight to moderate deposits	Moderate deposits	Slight deposits
Pistons	Slight deposits (one gouged surface)	Moderate to heavy deposits (mod etching on one piston)	Slight etching
Cups	Slight deposit	Slight scuffing	Slight scuffing

REMARKS: \* Thermocouple on right rear cylinder interferes with action of spring.

TABLE 1 - DESERT FIELD TESTS CYLINDER INSPECTION (CONTINUED)

	4	5	6	7
Vehicle	3/4 ton	3/4 ton	2½ ton	2½ ton
Class	M37	M37	M108	M220
Reg. No.	3B5757	2443415	4A1883	4A4212
<u>Condition of Cylinders</u>				
<u>Master Cylinder</u>	Operational	Operational	Operational	Operational
Cylinder Walls	Slight deposits	OK	OK	OK
Piston	Moderate sandy deposits	Slight deposits	Slight deposits	OK
Cups	Slight to moderate scuffing	Excessive scuffing	Slight scuffing	Slight to moderate scuffing
<u>Wheel Cylinders</u>				
Cylinder Walls	Moderate to excessive sandy deposits	Moderate deposits	Moderate sandy deposits	Slight deposits
Piston	Moderate to excessive sandy deposits	Moderate deposits moderate etching	Moderate sandy deposits	Slight deposits
Cups	**Slight scuffing	Slight to moderate deposits slight scuffing	Slight to moderate deposits slight scuffing	Slight scuffing

REMARKS: \*\* Heavy indentations in cup face RF &amp; RR.

TABLE I - DESERT FIELD TESTS CYLINDER INSPECTION (CONTINUED)

	8	9	10
Vehicle	5 ton	5 ton	5 ton
Class	M52	M62	M62
Reg. No.	5156241	54L35	00120342
<u>Condition of Cylinders</u>			
<u>Master Cylinder</u>	Operational	Operational	Operational
Cylinder Walls	Slight deposits	Slight deposits	Slight corrosion on front end
Piston	Slight deposits	Slight deposits	Moderate sandy deposits
Cups	Slight scuffing	Slight deposits slight scuffing	Slight scuffing
<u>Wheel Cylinders</u>	Operational	***Operational	Operational
Cylinder Walls	Slight to moderate deposits	Moderate to excessive sandy deposits	Excessive sandy deposits
Pistons	Moderate gritty deposits slight scoring	Moderate sandy deposits slight scoring	Moderate sandy deposits slight scoring
Cups	Moderate deposits slight scuffing	Moderate sandy deposits slight scuffing	Moderate sandy deposits slight scuffing

REMARKS: \*\*\* 5 cylinders in uniform condition, one cylinder (not forwarded for this test) in poor condition but operational.

\*\*\*\* RR Piston had a heavy scratch on surface.

TABLE II

## DESERT FIELD TESTS FLUID INSPECTION

Vehicle	Reg. No.	Boiling Point	Condition of Fluid
Original Fluid		318°F.	Light amber, clear
1	20977124	---	Slight precipitate
2	20975780	---	Slight precipitate
3	2A9096	---	Heavy sandy precipitate
4	3B5757	270°F	Moderate sandy precipitate
5	2443415	274°F	Moderate precipitate
6	4A1883	272°F	Moderate precipitate
7	4A4212	---	Slight precipitate
8	5156241	272°F	Slight sandy precipitate
9	54L35	274°F	Moderate sandy precipitate
10	00120342	272°F	Moderate sandy precipitate

## APPENDIX C

## Field Reports

U. S. ARMY ORDNANCE TEST ACTIVITY  
YUMA TEST STATION  
YUMA, ARIZONA

W. O. No. 0168  
RJSchick/bjg/2060

Refer to:

ORDBG-TA-ET-AU

TITLE: First Memorandum Report on Summer Test (1962) of All Weather Brake Fluid, OMS 5010.11.80200.02

TO: Commanding General, Aberdeen Proving Ground, Maryland  
ATIN: ORDBG-DPS-DF

Reporting Period: 15 May to 16 July 1962

Reference: DF, ORDBG-DPS-DF, dated 29 Aug 61, Incl. No. 1  
DF, ORDBG-DPS-DF, dtd, 6 Jun 62, Incl. No. 2

#### INTRODUCTION

Wheel cylinders and master cylinders provided by Coating and Chemical Laboratory were installed on one 1/4 ton truck, one 3/4 ton truck, two 2 1/2 ton trucks, and one 5 ton truck.

The brake system of each vehicle was filled with test brake fluid.

One vehicle of each weight class was instrumented with thermocouples to measure brake fluid temperature, brake cylinder skin temperature, and air temperature in the vicinity of the cylinder. The thermocouples were installed at the master cylinder and one wheel cylinder per axle.

Counters were installed on the above vehicles, and two other vehicles which will be equipped with test brakes, to measure the number of brake applications.

The vehicles were returned to normal facility service when the installations were completed.

Brake cylinders are being installed on 5 remaining facility vehicles.

#### RESULTS

The following table presents the mileages accumulated and the number of brake applications recorded.

The information contained in this report is tentative and should be so treated.

ORDBG-TA-ET-AU

TITLE: First Memorandum Report on Summer Test (1962) of All Weather  
Brake Fluid, OMS 5010.11.80200.02

TABLE I

<u>Vehicle</u>	<u>USA Reg. No.</u>	<u>Miles</u>	<u>Number of Brake Applications</u>
Truck, Utility, 1/4 Ton, 4x4, M38A1	20977124	419	2181
Truck, Cargo, 3/4 Ton, 4x4, M37	2443415	14	42
Truck, Van, 2 1/2 Ton, 6x6, M220	4A4212	12	35
Truck, Wrecker, 2 1/2 Ton, 6x6, M108	4A1883	248	624
Truck, Tractor, 5 Ton, 6x6, M52	5156241	147	493

Temperature data taken on Truck, Utility, 1/4 Ton, 4x4, M38A1, USA Reg. No. 20977124 are included as Inclosure 1 and Inclosure 2.

Maintenance was performed on the brake system of Truck, Wrecker, 2 1/2 Ton, 6x6, M108 after 192 miles of operation. There was a leak in the air pack due to a defective gasket. The gasket (FSN 2530-753-9337) was replaced.

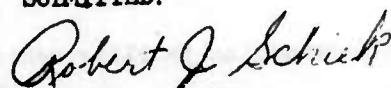
The mileage on the vehicles was accumulated on paved and secondary roads. The majority of the operation was on level terrain with occasional trips on hilly terrain.

#### FUTURE WORK

The remaining test master cylinders and wheel cylinders will be installed in two Trucks, Utility, 1/4 Ton, 4x4, M38A1, one Truck, Cargo, 3/4 Ton, 4x4, M37, and two Truck, Tractor, 5 Ton, 6x6, M62, and counters will be installed in the remaining one Truck, Cargo, 3/4 Ton, 4x4, M37 and one Truck, Tractor, 5 Ton, 6x6, M62.

Brake application counters will be installed in one each M37 and M62. Temperature data and brake application data will be taken.

SUBMITTED:



ROBERT J. SCHICK  
Project Engineer

APPROVED:

WILLIAM L. SNIDER  
Chief, Automotive Branch

The information contained in this report is tentative and should be so treated.

2 Incl  
1-2 Temperature data

## TEST DATA

U. S. ARMY ORDNANCE TEST ACTIVITY		PROJ. NO.	0168	Project Eng. R. Schick
TEST STATION		USA 2097n24		H/H/ 1/4 Ton
		FRICTION IN PSI. 0.05 TO 0.15		

DATE	(June)	TIME	18	18	26	26	26
		AMBIENT TEMPERATURE	0930	1000	1400	1410	1420
		ODOMETER READING	90	90	103	105	106
		COUNTER READING	1056	1061	1216	1220	1222
		RUNNING TIME BEFORE READING(Minutes)	257	276	1097	1105	1109
		TERRAIN	15	45	15	25	35
			← Level →	← Level →	← Level →	← Gravel →	← Paved →

## TEMPERATURES OF

1. Fluid Temp. Master Cyl.
2. Cyl. Skin Temp., Master Cyl.
3. Air Temp. In Vicinity, Master Cyl.
4. Fluid Temp., Front Wheel Cyl.
5. Cyl. Skin Temp., Front Wheel Cyl.
6. Air Temp. In Vicinity, Front Wheel Cyl.
7. Fluid Temp., Int. Wheel Cyl.
8. Cyl. Skin Temp., Int. Wheel Cyl.
9. Air Temp. in Vicinity, Int. Wheel Cyl.
10. Fluid Temp., Rear Wheel Cyl.
11. Cyl. Skin Temp., Rear Wheel Cyl.
12. Air in Vicinity, Rear Wheel Cyl.

88	88	126	134	137
88	86	126	134	137
88	87	127	134	132
91	105	156	131	130
91	105	156	131	130
91	102	156	137	130
---	---	---	---	---
---	---	---	---	---
90	102	134	126	125
88	102	133	126	125
88	102	133	126	125

## TEST DATA

U. S. ARMY ORDNANCE TEST CENTER		P.	Project Eng., R. Schick
DATE (June)	TIME	0168 USA 5156241	11/11/68 5-Ton
	AMBIENT TEMPERATURE	1520	
	ODOMETER READING	102	
	COUNTER READING	22599	
	RUNNING TIME BEFORE READING (Minutes)	---	
	TERRAIN	15	
		Level	
		Paved	

## TEMPERATURES °F

1. Fluid Temp. Master Cyl. 129
2. Cyl. Skin Temp., Master Cyl. 129
3. Air Temp. in Vicinity, Master Cyl. 129
4. Fluid Temp., Front Wheel Cyl. 102
5. Cyl. Skin Temp., Front Wheel Cyl. 102
6. Air Temp. in Vicinity, Front Wheel Cyl. 102
7. Fluid Temp., Int. Wheel Cyl. 102
8. Cyl. Skin Temp., Int. Wheel Cyl. 105
9. Air Temp. in Vicinity, Int. Wheel Cyl. 105
10. Fluid Temp., Rear Wheel Cyl. 105
11. Cyl. Skin Temp., Rear Wheel Cyl. 106
12. Air in Vicinity, Rear Wheel Cyl. 104

(16)

HEADQUARTERS YUMA TEST STATION  
YUMA, ARIZONA      W. O. No. 0160  
RJSchick/pjh/2339

Refer to:

STEYT-TOE

TITLE: Second Memorandum Report on Summer Test (1962) of All Weather Brake Fluid, OMS 5010.11.80200.02

TO: Commanding Officer, Aberdeen Proving Ground, Maryland  
ATTN: STTAP-DS-DF

Reporting Period: 17 July 1962 to 1 October 1962

#### INTRODUCTION

Test brake fluid, and brake application counters were installed on the remaining five facility vehicles: two 1/4-ton trucks, one 3/4-ton truck, and two 5-ton trucks. These vehicles were returned to facility service, and temperature data and brake application data were taken.

#### RESULTS

The following table presents the mileages accumulated and the number of brake applications recorded to date.

Table I.

Vehicle	USA Reg. No.	Miles	No. of Brake Applications
Truck, Utility, 1/4-ton, 4x4, M38A1	20977124	1403	5857
Truck, Utility, 1/4-ton, 4x4, M38A1	20975780	622	4792
Truck, Utility, 1/4-ton, 4x4, M38A1	2A9096	715	2535
Truck, Cargo, 3/4-ton, 4x4, M37	3B5757	620	2184
Truck, Cargo, 3/4-ton, 4x4, M37	2443415	824	2322
Truck, Wrecker, 2-1/2 ton, 6x6, M108	4A1883	1041	3553
Truck, Van, 2-1/2 ton, 6x6, M220	4A4212	1136	1390
Truck, Tractor, 5-ton, 6x6, M52	5156241	1243	2915
Truck, Wrecker, 5-ton, 6x6, M62	54L35	209	1582
Truck, Wrecker, 5-ton, 6x6, M62	00120342	655	977

Temperature data were taken on M52 truck, USA Reg No. 5156241, M57 truck, USA Reg No. 2443415, and M38A1 truck, USA Reg No. 20977124, and are presented in Inclosure 1, 2, and 3, respectively.

The information contained in this report is tentative and should be so treated.

STEYR-TOE

TITLE: Second Memorandum Report on Summer Test (1962) of All Weather Brake Fluid, OMS 5010.11.80200.02/0168

The mileage on the vehicles was accumulated on paved and secondary roads. The majority of the operation was on level terrain with occasional trips on hilly terrain.

One brake malfunction occurred during this period (Incl 4).

FUTURE WORK

Future work will include the collection of temperature data and brake application data. The brake parts will be removed at the end of the test, and returned to Coating and Chemical Laboratory.

SUBMITTED:

*Robert J. Schick*

ROBERT J. SCHICK  
Project Engineer

APPROVED:

*William L. Spader*  
WILLIAM L. SPADER  
Chief, Automotive Branch

The information contained in this report is tentative and should be so treated.

## DEFECT RECORD

DATE: 31 July 1962DEFECT NO.: 4 ENGINEER: R. SchickITEM UNDER TEST: All Weather Brake FluidVEHICLE TYPE: M220 REG NO: USA 4A4212DATE OF INCIDENT: 30 Jul 62 ODOMETER: 9316.7 PART MILEAGE:DEFICIENCY  SHORTCOMING  IMPROVEMENTS  DESIGN  MANUFACTURING SNL GROUP NOMENCLATURE PART NO.

12 Cylinder, Air-Hydraulic, Assembly 7376689

SYNOPSIS:

The brakes were inoperative due to lack of fluid.

CAUSE:

A faulty thread on the plate, ORD No. BX375911 allowed aluminum filings into the fluid chambers. These filings disrupted sealing action allowing brake fluid into the air side of the air-hydraulic cylinder assembly.

ACTION:

The air-hydraulic cylinder assembly was replaced.

## TEST DATA

Automotive Branch  
U. S. ARMY ORDNANCE TEST ACTIVITY  
Yuma Test Station, Yuma, Arizona

Project No. 0168      Project Engr. R. Schick  
Vehicle USA Reg. No. 5156245  
Alt. ft., temp., in., etc. unless otherwise noted

5-Tow  
Date, September

Time

Ambient temperature

Odometer reading

Running time bef. reading (min)

Terrain

Temperature OF

1. Fluid temp., master cyl

2. Cyl skin temp., master cyl

3. Air temp in vicinity, master cyl

4. Fluid temp., front wheel cyl

5. Cyl skin temp., front wheel cyl

6. Air temp in vicinity, front wheel cyl

7. Fluid temp., int wheel cyl

8. Cyl skin temp., int wheel cyl

9. Air temp in vicinity, int wheel cyl

10. Fluid temp., rear wheel cyl

11. Cyl skin temp., rear wheel cyl

12. Air in vicinity, rear wheel cyl

	27	27	27	27	27	27	27
Date, September	0915	0925	0935	0945	0950	1000	
Time	0900	0915	0925	0935	0945	0950	
Ambient temperature	80.6	81.2	81.5	81.9	82.8	82.4	82.8
Odometer reading	23804	23809	23814	23819	23824	23829	23833
Running time bef. reading (min)	0	15	25	35	45	50	60
Terrain	← Level → Paved						

	81	95	106	115	115	115	114	120
Date, September	81	95	102	115	116	116	119	120
Time	81	95	102	115	116	116	119	120
Ambient temperature	82	85	82	85	92	95	100	130
Odometer reading	80	85	85	85	100	105	110	
Running time bef. reading (min)	80	85	85	85	100	105	110	
Terrain	← Level → Paved							
	84	84	80	85	96	96	104	
Temperature OF	84	84	80	85	96	96	104	
1. Fluid temp., master cyl	84	84	80	85	96	96	104	
2. Cyl skin temp., master cyl	82	84	85	85	96	96	104	
3. Air temp in vicinity, master cyl	82	84	85	85	99	101	105	
4. Fluid temp., front wheel cyl	84	84	80	85	96	96	104	
5. Cyl skin temp., front wheel cyl	80	85	85	85	100	105	110	
6. Air temp in vicinity, front wheel cyl	80	85	85	85	100	105	110	
7. Fluid temp., int wheel cyl	84	84	80	85	96	96	104	
8. Cyl skin temp., int wheel cyl	82	84	85	85	96	96	104	
9. Air temp in vicinity, int wheel cyl	82	84	85	85	99	101	105	
10. Fluid temp., rear wheel cyl	83	90	87	94	104	105	111	
11. Cyl skin temp., rear wheel cyl	82	90	95	103	104	120	130	
12. Air in vicinity, rear wheel cyl	82	90	90	96	104	109	130	

**TEST DATA**

U. S. ARMY ORDNANCE TEST ACTIVITY		Project No. 0160	Project Engr. R. Schick
YAMA TEST STATION, YAMA, ARIZ.		Vernon USA Reg. No. 2443415	Date
3/4-ton		TEMP. IN °C., AND PRESS. IN PSI. UNLESS OTHERWISE INDICATED	
Date	Time	← July →	← August →
1345	1420	0955	1010 1015
Ambient temperature		109	90 90
Odometer reading		6836	6842 7127 7130 7133
Running time before reading (min)		15	25 0 15 20
Terrain		← Level →	Gravel ← → Paved
Temperatures of			
1. Fluid temp master cyl		86	95 104 110 115
2. Cyl skin temp, master cyl		35	95 104 110 115
3. Air temp in vicinity, master cyl		85	95 104 110 115
4. Fluid temp, front wheel cyl		90	103 104 109 115
5. Cyl skin temp, front wheel cyl		38	100 103 109 116
6. Air temp in vicinity, front wheel cyl		75	84 110 135 138
7. Fluid temp, int wheel cyl			
8. Cyl skin temp, int wheel cyl			
9. Air temp in vicinity, int wheel cyl			
10. Fluid temp, rear wheel cyl		75	82 109 115 123
11. Cyl skin temp, rear wheel cyl		92	100 106 115 123
12. Air in vicinity, rear wheel cyl		86	24 110 135 140

(21)

## TEST DATA

U. S. ARMY ORDNANCE TEST ACTIVITY		Product No. 0168	PROJECT ENGR. R. Spinick
Yuma Test Station, Yuma, Arizona		Vehicle USA Reg No. 20977124	DATE
			A.I. TEMP. IN °F. ALL PRESS. IN PSI UNLESS OTHERWISE NOTED
1/4-Ton			
Date		19	12
Time		1040	1125
Ambient temperature		92	99
Odometer reading		1556	1561
Running time bef reading (min)		15	15
Terrain	← Level — Growth Level	10	10
Temperatures Op	Paved		
1. Fluid temp, master cyl		116	125
2. Cyl skin temp, master cyl		116	125
3. Air temp in vicinity, master cyl		113	115
4. Fluid temp, front wheel cyl		109	103
5. Cyl skin temp, front wheel cyl		109	103
6. Air temp in vicinity, front wheel cyl		116	105
7. Fluid temp, int wheel cyl		119	125
8. Cyl skin temp, int wheel cyl		124	124
9. Air temp in vicinity, int wheel cyl		125	125
10. Fluid temp, rear wheel cyl		106	108
11. Cyl skin temp, rear wheel cyl		106	108
12. Air in vicinity, rear wheel cyl		109	106

(22)

HEADQUARTERS YUMA TEST STATION  
YUMA, ARIZONA

W. O. No.: 7200  
KIBohi/pjh/2060

Refer to:

STEYT-TOE

TITLE: Third Memorandum Report on Summer Test (1962) of All Weather Brake Fluid, ANCIS 5010.11.80200.02

TO: Commanding Officer, Aberdeen Proving Ground, Aberdeen, Maryland,  
ATTN: STEAP-DS-DF

Reporting Period: 2 October 1962 to 17 December 1962

INTRODUCTION

Tests have been completed on the M38A1 truck, USA Reg. No. 20977124, M52 truck, USA Reg. No. 5156241, and M108 truck, USA Reg. No. 4A1883. The brake parts from these vehicles will be removed and returned to Coating and Chemical Laboratory.

RESULTS

The following table presents the mileages accumulated and the number of brake applications recorded to date.

Table I. Mileage and Brake Applications

<u>Vehicle</u>	<u>USA Reg. No.</u>	<u>Miles</u>	<u>No. of Brake Applications</u>
Truck, Utility, 1/4-ton, 4x4, M38A1	20977124	2713	9500
Truck, Utility, 1/4-ton, 4x4, M38A1	20975780	1748	9315
Truck, Utility, 1/4-ton, 4x4, M38A1	219096	1265	5735
Truck, Cargo, 3/4-ton, 4x4, M37	3B5757	2605	7930
Truck, Cargo, 3/4-ton, 4x4, M37	2443415	1656	5266
Truck, Wrecker, 2-1/2 ton, 6x6, M108	4A1883	2402	4924
Truck, Van, 2-1/2 ton, 6x6, M220	4A4212	2794	2974
Truck, Tractor, 5-ton, 6x6, M52	5156241	1770	3537
Truck, Wrecker, 5-ton, 6x6, M62	54L35	1273	4838
Truck, Wrecker, 5-ton, 6x6, M62	00120342	1056	1762

Temperature data were taken on M108 truck, USA Reg. No. 4A1883, M52 truck, USA Reg. No. 5156241, and M37 truck, USA Reg. No. 2443415, and are presented in Inclosures 1, 2, 3, and 4, respectively.

The information contained in this report is tentative and should be so treated.

STEYT-TOE

TITLE: Third Memorandum Report on Summer Test (1962) of All Weather Brake Fluid, AMCIS 5010.11.80200.02/7200

The mileage on the vehicles was accumulated on paved and secondary roads. The majority of the operation was on level terrain with occasional trips on hilly terrain.

Two brake malfunctions occurred during this period (Inel 5 and 6).

FUTURE WORK

Future work will include the collection of brake application data for the remaining vehicles. These brake parts will be removed at the end of the test, and returned to Coating and Chemical Laboratory.

SUBMITTED:

APPROVED:

KENNETH H. BOHII  
Test Director

IAN C. FORREST  
Acting Chief, Mobility Branch

The information contained in this report is tentative and should be so treated.

## DEFECT RECORD

DATE: 29 Oct 62DEFECT NO.: 5ENGINEER: BohiITEM UNDER TEST: All Weather Brake FluidVEHICLE TYPE: M108REG NO.: USA 4/1883DATE OF INCIDENT: 24 Sep 62ODOMETER: 19048PART MILEAGE: 1636DEFICIENCY SHORTCOMING IMPROVEMENTS DESIGN MANUFACTURING SNL GROUPNOMENCLATUREPART NO.

12

7539314

SYNOPSIS OF DEFECT:

The brakes were inoperative due to lack of fluid.

CAUSE:

Rubber seal (7539314) was torn allowing brake fluid into the air side of the air-hydraulic cylinder assembly. Since the rubber seal showed no signs of chemical deterioration, the cause was probably fatigue.

ACTION TAKEN:

The air-hydraulic cylinder was replaced.

## DEFECT RECORD

DATE: 14 Dec 62

DEFECT NO.: 6 ENGINEER: Bohi

ITEM UNDER TEST: All Weather Brake Fluid

VEHICLE TYPE: M37 REG. NO.: USA 2443415

DATE OF INCIDENT: 7 Dec 62 ODOMETER: 8421 PART NO.: 1664

DEFICIENCY  SHORTCOMING  IMPROVEMENTS  DESIGN  OPERATING 

SNL GROUP

MANUFACTURER

PART NO.

SYNOPSIS OF DEFECT:

Brake application was soft and spongy.

CAUSE:

Washer seal right front wheel was defective.

ACTION TAKEN:

The washer seal was replaced.

## TEST DATA

## DIRECTORATE OF GROUND TESTING

Yuma Test Station, Yuma, Arizona

Project No. 7200  
 Vehicle 462833, 2-1/2 ton Date \_\_\_\_\_  
 All temp in °F, all press in psi unless otherwise noted

Date	October	Time	14:00	14:35	14:45	14:55	4	4	4
Ambient temperature			93						
Odometer reading			19114	19119	19124	19129			
Running time before reading (min.)			0	5	15	25			
Terrain									
<hr/>									
ITEMS OF TEST									
1.	Fluid temp master cyl		91	100	90	94			
2.	Cyl skin temp master cyl		91	90	85	94			
3.	Air temp in vicinity, master cyl		91	25	33	27			
4.	Fluid temp, front wheel cyl		91	24	27	109			
5.	Cyl skin temp, ft wheel cyl		91	95	87	91			
6.	Air temp in vicinity, ft wheel cyl		91	104	24	104			
7.	Fluid temp, int wheel cyl								
8.	Cyl skin temp, int wheel cyl								
9.	Air temp in vicinity, int wheel cyl								
10.	Fluid temp, rear wheel cyl		107	104	95	104			
11.	Cyl skin temp, rear wheel cyl		107	100	91	100			
12.	Air in vicinity, rear wheel cyl		107	95	84	82			

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**TEST DATA**

**DIRECTORATE OF GROUND TESTING  
Yuma Test Station, Yuma, Arizona**

Project No. 7200  
Vehicle 4AU033, 2-1/2 ton  
All temp in °F, all press in psi unless otherwise noted.

Date	October	25	25	25	25	25	25	25	25	25	25	25	25
Time	0915	0930	0950	1000	1010	1020	1030	1040	1050	1060	1070	1080	1090
Ambient temperature	72												
Cadometer reading	19411	34116	19421	19426	19431	19436	19441	19446	19451	19456	19461	19466	19471
Counter reading	4390	4393	4402	4403	4406	4409	4411	4412	4413	4414	4415	4416	4418
Running time before reading (min.)	0	15	35	45	55	65	75	85	95	105	115		
Terrain	Level												
Paved													
<b>TEMPERATURE, °F</b>													
1. Fluid temp master cyl	37	25	20	11	116	116	116	116	116	116	116	116	116
2. Cyl skin temp, master cyl	39	37	35	25	125	120	120	120	120	120	120	120	120
3. Air temp in vicinity, master cyl	32	25	21	112	115	115	115	115	115	115	115	115	115
4. Fluid temp, ft wheel cyl	35	25	22	95	95	97	97	97	97	97	97	97	97
5. Cyl skin temp, ft wheel cyl	36	24	21	92	101	107	107	107	107	107	107	107	107
6. Air temp in vicinity, ft wheel cyl	33	25	21	87	95	100	100	100	100	100	100	100	100
7. Fluid temp, int wheel cyl	25	22	105	115	124	125	125	125	125	125	125	125	125
8. Cyl skin temp, int wheel cyl	29	22	98	109	120	120	120	120	120	120	120	120	120
9. Air temp in vicinity, int wheel cyl	20	22	97	25	104	115	115	115	115	115	115	115	115
10. Fluid temp, rear wheel cyl	35	27	25	99	105	111	111	111	111	111	111	111	111
11. Cyl skin temp, rear wheel cyl	37	29	29	100	113	119	119	119	119	119	119	119	119
12. Air in vicinity, rear wheel cyl	20	100	113	119	135	143	143	143	143	143	143	143	143

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## TEST DATA

**DIRECTORATE OF GROUND TESTING**  
**Yuma Test Station, Yuma, Arizona**

Project No. 7200      Project Engr. Bohi  
 Vehicle USA 5156241, 5-ton, Date  
 All temp in °F, all press in psi unless otherwise noted

Date	October	2	2	2	2	2	2	2	2	2	2
Time		1330	1345	1355	1405	1415	1430	1438	1450	1450	1450
Ambient temperature		100	101	101	101	101	101	101	101	101	101
Odometer reading		23854	23855	23856	23857	23858	23859	23860	23861	23862	23863
Running tire before reading (min)		3	15	15	15	15	15	15	15	15	15
Terrain	Lot → Level →										
<b>TEMPERATURES °F</b>											
1.	Fluid temp, master cyl	105	122	130	135	135	141	141	141	141	141
2.	Cyl skin temp, master cyl	105	112	125	125	125	144	144	144	144	144
3.	Air temp in vicinity, master cyl	105	134	135	144	145	149	152	153	153	153
4.	Fluid temp, ft wheel cyl	102	102	129	102	102	117	117	123	123	123
5.	Cyl skin temp, ft wheel cyl	105	109	112	114	115	120	124	124	124	124
6.	Air temp, in vicinity, ft wheel cyl	103	102	102	102	113	120	120	122	122	122
7.	Fluid temp, int wheel cyl	103	103	109	109	113	120	123	123	123	123
8.	Cyl skin temp, int wheel cyl	103	109	109	109	113	120	122	122	122	122
9.	Air temp in vicinity, int wheel cyl	103	109	109	109	113	120	123	123	123	123
10.	Fluid temp, rear wheel cyl	105	109	110	110	115	121	122	124	124	124
11.	Cyl skin temp, rear wheel cyl	105	113	110	110	115	114	117	117	117	117
12.	Air in vicinity, rear wheel cyl	105	111	114	120	123	135	137	137	137	137
5th gear hi		11	11	11	11	11	11	11	11	11	11

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## TEST DATA

## DIRECTORATE OF GROUND TESTING

Project No. 7200      Project Engr Bohi  
 Vehicle USA 2443415 3/-ton Date \_\_\_\_\_  
 Yuma Test Station, Yuma, Arizona  
 All temp in °F, all press in psi unless otherwise noted

Date	October	Time	0945	0055	1005	1	1	1	1025	1040	1050
Ambient temperature	85	86	87	88	89	89	91	92			
Odometer reading	7057	7332	7609	7675	7680	7685	7689				
Running time before reading (min)	0	10	20	30	40	55	65				
Terrain											

## TEMPERATURES °F

1. Fluid temp, master cyl 92 103 109 115 115 118 117
2. Cyl skin temp, master cyl 92 105 106 114 115 118 117
3. Air temp in vicinity, master cyl 95 107 108 111 115 113
4. Fluid temp, ft wheel cyl 80 96 95 107 100 106 104
5. Cyl skin temp, ft wheel cyl 84 95 95 107 104 106 104
6. Air temp in vicinity, ft wheel cyl 82 105 105 115 114 111
7. Fluid temp, int wheel cyl
8. Cyl skin temp, int wheel cyl
9. Air temp in vicinity, int wheel cyl
10. Fluid temp rear wheel cyl 85 100 105 110 111 111 118
11. Cyl skin temp, rear wheel cyl 85 101 105 111 115 117 122
12. Air in vicinity, rear wheel cyl 85 110 113 121 130 125 126

(30)

HEADQUARTERS, YUMA TEST STATION  
YUMA, ARIZONA

Project No.: 593-21-061  
KHBohi/kam/2060

Refer to:

STEYT-TOE

TITLE: Fourth and Final Memorandum Report on Summer Test (1962)  
of All Weather Brake Fluid

TO: Commanding Officer, Aberdeen Proving Ground, Aberdeen,  
Maryland, ATTN: STEAP-DS-DF

Reporting Period: 18 December 1962 through 25 February 1963

INTRODUCTION

Test operations have been completed with the brake fluid and brake components on all the vehicles. All the parts have been removed and turned in to supply for shipment to the Coating and Chemical Laboratory.

RESULTS

The following table presents the final mileages accumulated and the number of brake applications recorded.

Table 1. Mileage and Brake Applications

<u>Vehicle</u>	<u>USA Reg. No.</u>	<u>Miles</u>	<u>No. of Brake Applications</u>
Truck, utility, 1/4-ton, 4x4, M38A1	20977124	2718	9500
Truck, utility, 1/4-ton, 4x4, M38A1	20975780	2314	12788
Truck, utility, 1/4-ton, 4x4, M38A1	2A9096	1458	7401
Truck, cargo, 3/4-ton, 4x4, M37	3B5757	2787	9288
Truck, cargo, 3/4-ton, 4x4, M37	2443415	2131	7028
Truck, wrecker, 2-1/2-ton, 6x6, M108	4A1883	2402	4924
Truck, van, 2-1/2-ton, 6x6, M220	4A4212	3064	3379
Truck, tractor, 5-ton, 6x6, M52	5156241	1770	3537
Truck, wrecker, 5-ton, 6x6, M62	54L35	1896	6800
Truck, wrecker, 5-ton, 6x6, M62	00120342	1130	2089

All of the vehicles are facility type vehicles that receive normal usage on paved and secondary roads.

The information contained in this report is tentative and should be so treated.

STEYT-TOE

TITLE: Fourth and Final Memorandum Report on Summer Test (1962)  
of All Weather Brake Fluid, Project No. 593-21-061

Maintenance performed on the brake systems during the complete test was as follows:

28 May 1962, USA Reg No. 4A1883, mileage 0

Received master cylinder with damaged plunger seal. The seal was replaced and the master cylinder installed in the vehicle.

28 May 1962, USA Reg No. 5156241, mileage 0

Received master cylinder with bracket broken off. Replaced master cylinder with another one.

3 July 1962, USA Reg No. 4A1883, mileage 169

Brake application was soft and spongy. Removed and inspected hydropack and found leak in air hydraulic brakes. Replaced gasket (FSN-2530-753-9337), inlet and exhaust valve cage and cap.

30 July 1962, USA Reg No. 4A4212, mileage 380

The brakes were inoperative because of a lack of fluid. A faulty thread on the plate (ORD No. EX375911) allowed aluminum filings into the fluid chambers. These filings disrupted the action allowing brake fluid into the air side of the air hydraulic cylinder assembly. The air hydraulic cylinder assembly was replaced.

24 August 1962, USA Reg No. 5156241, mileage 763

Brakes were reported soft and spongy. Found brake fluid level low and added 600 ml of brake fluid to master cylinder. Bleed master cylinder and air pack unit and checked wheel cylinder adjustment.

24 September 1962, USA Reg No. 4A1883, mileage 1649

Added 377 ml of brake fluid to master cylinder to bring the brake fluid to correct level. Removed old air pack and installed new pack (FSN-2530-040-2188). Returned vehicle to service.

STEYT-TOE

TITLE: Fourth and Final Memorandum Report on Summer Test (1962)  
of All Weather Brake Fluid, Project No. 593-21-061

23 October 1962, USA Reg No. 3B5757, mileage 951

Filled master cylinder with 400 ml of brake fluid. Bleed lines and check wheel adjustments. Tightened fitting on line in front of the master cylinder.

12 December 1962, USA Reg No. 2443415, mileage 1664

Brakes were reported spongy. Replaced a washer seal on right front wheel. Added 200 ml of brake fluid to the master cylinder.

14 December 1962, USA Reg No. 5156241, mileage 1770

Added 400 ml of brake fluid to master cylinder. When removing test components at the conclusion of test, the right front cylinder, right intermediate cylinder, and the left rear cylinder were all found to be leaking with foreign material visible in the cylinders.

17 December 1962, USA Reg No. 20977124, mileage 2723

When removing test parts at end of test, the right rear cylinder was found to be leaking past the cup with foreign material visible in the cylinder.

8 January 1963, USA Reg No. 00120342, mileage 1059

Brakes were reported to be soft and spongy. Added 250 ml of brake fluid to the master cylinder and bled the lines.

7 January 1963, USA Reg No. 54L35, mileage 1272

Brakes not operating correctly. Added 450 ml of brake fluid to the brake cylinder but found no leaks or troubles in the cylinders or the lines.

18 January 1963, USA Reg No. 4A4212, mileage 3064

Test brake fluid was removed from brake system by mistake and standard fluid added. The test cylinders were removed and cleaned with compressed air and will be shipped to the Coating and Chemical Laboratory dry.

30 January 1963, USA Reg No. 2A9096, mileage 1458

Added 450 ml of brake fluid to the master cylinder before removing the vehicle from the test. Found no leaks or trouble.

STEYT-TOE

TITLE: Fourth and Final Memorandum Report on Summer Test (1962)  
of All Weather Brake Fluid, Project No. 593-21-061

1 February 1963, USA Reg No. 2443415, mileage 2131

Added 40 ml of test brake fluid to the master cylinder. Found both cups of right rear cylinder and right front cylinder leaking slightly.

7 February 1963, USA Reg No. 3B5757, mileage 2787

Added 280 ml of brake fluid to the master cylinder before removing test parts. Also found the four wheel cylinders to be leaking.

12 February 1963, USA Reg No. 20975780, mileage 2314

Added 80 ml of test brake fluid to the master cylinder before removing test brakes. Also found the left rear and right front wheel cylinders leaking slightly and the left front cylinder leaking heavily.

15 February 1963, USA Reg No. 00120342, mileage 1130

Added 270 ml of test brake fluid to the master cylinder before removing test brakes. Also found the right intermediate and the right rear cylinder leaking slightly with some foreign material visible in the cylinders.

25 February 1963, USA Reg No. 54L35, mileage 1896

Added 280 ml of test brake fluid to the master cylinder to bring to correct level. Also found left front cylinder cups leaking before the test cylinders were removed from the vehicle.

No brake malfunction occurred during this period.

SUBMITTED:

*Kenneth H. Boni*  
KENNETH H. BONI  
Project Engineer

APPROVED:

*Ian C. Forrest*  
IAN C. FORREST  
Acting Chief, Mobility Branch

The information contained in this report is tentative and should be so treated.

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AD No	Accession No U.S. Army Coating & Chemical Laboratory Aberdeen Proving Ground, Md., CCL # 147 DESERT FIELD TEST - ALL WEATHER BRAKE FLUID - Charles B. Jordan, Rpt No. 147, 16 August 1963, 39 pgs, AMCMCS Code No. 5025.11.802, DA Proj No 1-H-0-24401-108	Unclassified	Unclassified	AD No U.S. Army Coating & Chemical Laboratory Aberdeen Proving Ground, Md., CCL # 147 DESERT FIELD TEST - ALL WEATHER BRAKE FLUID - Charles B. Jordan, Rpt No. 147, 16 August 1963, 39 pgs, AMCMCS Code No. 5025.11.802, DA Proj No 1-H-0-24401-108	Accession No U.S. Army Coating & Chemical Laboratory Aberdeen Proving Ground, Md., CCL # 147 DESERT FIELD TEST - ALL WEATHER BRAKE FLUID - Charles B. Jordan, Rpt No. 147, 16 August 1963, 39 pgs, AMCMCS Code No. 5025.11.802, DA Proj No 1-H-0-24401-108
	<p>The object of this test was to evaluate the high temperature field performance of an all weather hydraulic brake fluid. This report covers the results of desert tests at Yuma Test Station, Arizona.</p> <p>New brake cylinders were packaged with the all weather brake fluid and installed on <math>\frac{1}{4}</math> ton, <math>3/4</math> ton, <math>2\frac{1}{2}</math> ton and 5 ton</p>			<p>The object of this test was to evaluate the high temperature field performance of an all weather hydraulic brake fluid. This report covers the results of desert tests at Yuma Test Station, Arizona.</p> <p>New brake cylinders were packaged with the all weather brake fluid and installed on <math>\frac{1}{4}</math> ton, <math>3/4</math> ton, <math>2\frac{1}{2}</math> ton and 5 ton</p>	
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<p><b>Unclassified</b></p> <p>facility vehicles; all weather fluid was placed in the brake systems; the vehicles were then placed in normal facility operation during the test period of 12 June 1962 to 25 February 1963.</p> <p>The all weather brake fluid performed satisfactorily in all vehicles throughout the test period.</p>	<p><b>Unclassified</b></p> <p>facility vehicles; all weather fluid was placed in the brake systems; the vehicles were then placed in normal facility operation during the test period of 12 June 1962 to 25 February 1963.</p> <p>The all weather brake fluid performed satisfactorily in all vehicles throughout the test period.</p>
<p><b>Unclassified</b></p> <p>facility vehicles; all weather fluid was placed in the brake systems; the vehicles were then placed in normal facility operation during the test period of 12 June 1962 to 25 February 1963.</p> <p>The all weather brake fluid performed satisfactorily in all vehicles throughout the test period.</p>	<p><b>Unclassified</b></p> <p>facility vehicles; all weather fluid was placed in the brake systems; the vehicles were then placed in normal facility operation during the test period of 12 June 1962 to 25 February 1963.</p> <p>The all weather brake fluid performed satisfactorily in all vehicles throughout the test period.</p>

AD No <u>U.S. Army Coating &amp; Chemical Laboratory</u> Aberdeen Proving Ground, Md., CCL # 147 DESERT FIELD TEST - ALL WEATHER BRAKE FLUID - Charles B. Jordan, Rpt No. 147, 16 August 1963, 39 pgs, AMCMCS Code No. 5025.11.802, DA Proj No I-H-0-24401-108	Accession No <u>Unclassified</u>	Unclassified	AD No <u>U.S. Army Coating &amp; Chemical Laboratory</u> Aberdeen Proving Ground, Md., CCL # 147 DESERT FIELD TEST - ALL WEATHER BRAKE FLUID - Charles B. Jordan, Rpt No. 147, 16 August 1963, 39 pgs, AMCMCS Code No. 5025.11.802, DA Proj No I-H-0-24401-108	Accession No <u>U.S. Army Coating &amp; Chemical Laboratory</u> Aberdeen Proving Ground, Md., CCL # 147 DESERT FIELD TEST - ALL WEATHER BRAKE FLUID - Charles B. Jordan, Rpt No. 147, 16 August 1963, 39 pgs, AMCMCS Code No. 5025.11.802, DA Proj No I-H-0-24401-108
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